Eating Disorders and Their Putative Risk Factors Among Female German Professional Athletes

Abstract

This study examines putative non-sport-specific and sport-specific risk factors for eating disorders (ED) among groups of professional female athletes vs. non-athletes. In detail, societal pressure to be thin, its internalisation, body dissatisfaction, sports pressure, and early specialisation were investigated. The cross-sectional study included 46 aesthetic and 62 ball game sports athletes and 108 age-matched non-athletes. Study methods comprised a clinical interview to detect ED and questionnaires. More athletes from aesthetic (17%) than from ball game sports (3%) and non-athletes (2%) suffered from ED. Aesthetic sports athletes did not differ from non-athletes in non-sport-specific factors, but obtained higher levels than ball game sports athletes in sport-specific variables ($p<.01$). All factors together accounted for 57.3% of variation in disordered eating, with sports pressure and body dissatisfaction as significant predictors. The results confirm ED risk for German aesthetic athletes, and indicate the importance of sports pressure and body dissatisfaction in explaining athletes' vulnerability.

Keywords:
sports pressure, body dissatisfaction, aesthetic and ball game sports, women and sport, elite performance

Eating disorders and their putative risk factors among female German professional athletes

Disordered eating in athletes has been frequently studied. The risk of developing eating disorders (ED) among athletes varies, depending on gender, sports discipline and competitive level (Petrie & Greenleaf, 2007). Adolescent females who participate at a professional level in aesthetic sports (e.g. rhythmic gymnastics) have a particular high risk of ED (Thompson & Sherman, 2010). In these sports, an outstandingly lean body build and low weight are promoted, because a leaner body or a thinner appearance can enhance performance and/or lead to a better score in judge-assessed sports (Sherman & Thompson, 2006). In sports in which shape or weight are considered less important, such as ball game sports (e.g. basketball, field hockey), female athletes have a lower risk, but are still more prone to develop ED than non-athletes (Sundgot-Borgen, 1993). Large-scale studies from Norway revealed ED prevalence rates of over 30% for aesthetic sports athletes, 11% for ball game sports athletes and 5–9% for non-athletes (Sundgot-Borgen, 1993; Sundgot-Borgen & Torstveit, 2004). Similar results were found in a large study in Australia (Byrne & McLean, 2002). Given these figures and the consequences of disordered eating for physical and mental health as well as for athletes' performance and social relationships (Scoffier, Woodman, & d'Arripe-Longueville, 2011; Sundgot-Borgen & Torstveit, 2010), effective prevention is necessary in professional sports. Only by understanding the causes of ED can targeted prevention strategies be developed. For athletes non-sport-specific risk factors (for a detailed list see Jacobi, Hayward, de Zwaan, Kraemer, and Agras (2004)) and sport-specific factors need to be considered (Sundgot-Borgen et al., 2013). Experts assume that the increased risk for ED in athletes is triggered by sport-specific factors (International Olympic Committee Medical Commission Working Group on "Women in Sport", 2005). According to Sundgot-Borgen (1994) one sport-related factor is early specialisation, i.e. selecting a sport when

prepubertal, before the body matures sufficiently. This may yield a discrepancy between the adult body type and the sport-specific body ideal and can result in disordered eating. Another sport-specific factor is sports pressure that encourages possession of an ideal body for physical performance (Petrie & Greenleaf, 2007). The degree of sports pressure and how much it promotes a thin physique varies between sports due to their different body requirements (Byrne & McLean, 2002). This means that athletes can be exposed to two sources of pressure: the sports pressure and the Western societal pressure to be thin. The aetiological model of Petrie and Greenleaf (2007) for ED in athletes embodies this idea: Being exposed to both sources of pressure leads to an increased likelihood of internalisation of societal body ideals and body dissatisfaction, depending on the discrepancy between the real and the ideal body. This results in higher risk of restrained eating and ED. More specifically, *societal pressure* to be thin is present for athletes and non-athletes, e.g. through the media (Stice, 2002). In contrast, *sports pressure* regarding physique, for example that exerted by team-mates or coaches (de Bruin, Oudejans, & Bakker, 2007; Thompson & Sherman, 2010), affects only athletes. The impact of this pressure is significantly influenced by the degree of *internalisation* of socially defined body ideals into the personal belief system (Stice & Shaw, 2002). Unattainable internalised ideals lead to *body dissatisfaction*, a main risk factor for ED in general populations (Jacobi et al., 2004; Stice, 2002). The relationship between body dissatisfaction and ED in athletes is less evident since athletes participating in high-risk sports do not seem to show increased body dissatisfaction (Hausenblas & Downs, 2001; Smolak, Murnen, & Ruble, 2000).

To explain ED in professional sports it is necessary to investigate sport-specific and non-sport-specific factors. Given that sport studies rarely consider both at the same time or are limited to body dissatisfaction as a non-sport-specific factor, this study investigates societal pressure to be thin, the internalisation of a thin ideal, and body dissatisfaction,

together with sports pressure and early specialisation. Among athletes these factors have been insufficiently investigated and thus far, due to the lack of longitudinal studies, they can only be considered as putative risk factors. Before their risk factor status is tested longitudinally, their presence among athletes needs to be confirmed, for example through their increased incidence in groups with high disordered eating or ED (Jacobi et al., 2004; Kraemer et al., 1997). This study investigated the above-mentioned putative risk factors among female German aesthetic and ball game sports professional athletes; these are sport groups with elevated prevalence of ED according to international studies (see above).

Due to the diversity in terms of societal, cultural, and sport-specific training conditions in different countries (Digel & Burk, 2004), it is necessary to verify whether German athletes indeed have an increased risk of ED and are therefore appropriate subjects among whom to investigate putative ED risk factors. So far there is little empirical evidence for this: German ball game sports athletes have scarcely been investigated and results for aesthetic sports are inconsistent. With regard to eating-related pathology, Rosendahl, Bormann, Aschenbrenner, Aschenbrenner, and Strauß (2009), Salbach, Klinkowski, Pfeiffer, Lehmkuhl, and Korte (2007) and, with some limitations, Schneider, Bayios, Pfeiffer, Lehmkuhl, and Salbach-Andrae (2009) did not find differences between aesthetic sports athletes and non-athletes. In contrast, Krentz and Warschburger (2011a) (2011b) reported an increased level of disordered eating for aesthetic compared with ball game sports athletes and non-athletes. These few and partly contradictory results, based on self-report methods only, do not permit assessment of the eating pathology status of German professional athletes. A further investigation of the prevalence of ED among these athletes is necessary before potential risk factors for ED can be examined.

Considering the methodological problems of previous sport studies, such as the lack of adequate control groups (Jacobi et al., 2004; Smolak et al., 2000), age-cohort effects

(Thompson & Sherman, 2010; Torstveit, Rosenvinge, & Sundgot-Borgen, 2008) and data collection using only self-report methods, which may be unreliable (Sundgot-Borgen, 1993), this study investigated:

1. The prevalence rates of ED among German female aesthetic sports and ball game sports athlete controls and age-matched non-athletes, using clinical interviews.
2. The presence of putative risk factors for ED among aesthetic sports athletes in comparison with ball game sports and age-matched non-athletes.
3. The predictive power of sport-specific and non-sport-specific factors for disordered eating among athletes.

Method

Participants

In this study 108 German female professional athletes aged 12 to 34 years and 108 age-matched female non-athletes took part. Athletes were recruited with assistance of their coaches; non-athletes were recruited from high schools, universities, and at summer camps. Non-athletes were required not to have competed at a professional level in any sports before. They were allowed to participate in recreational sports for up to eight hours per week. For further information on the recruitment process and exclusion criteria see Figure 1. In this study a professional athlete is defined as somebody who competes on a national or international level (Smolak et al., 2000). According to the categories of Sundgot-Borgen (1994) , 46 aesthetic sports athletes (19 team vaulters, 11 rhythmic gymnasts, 10 figure-skaters, 3 artistic gymnasts, 3 synchronized swimmers), and 62 ballgame sports athletes (field hockey players) participated. Detailed group characteristics are summarized in Table 1. The study was conducted with the approval of the Ruhr-University Bochum Medical School Ethics Committee. All participants and parents for those younger than 18 years provided informed consent.

Insert Figure 1 here

Measurements

The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID; Wittchen, Zaudig, & Fydrich, 1997) and a self-designed questionnaire containing items related to training history, health, weight and eating behaviour were used, in addition to the following instruments:

Patient Health Questionnaire (PHQ; Gräfe, Zipfel, Herzog, & Löwe, 2004)

The PHQ is a self-administered screening instrument for current mental disorders. The used modules mood, anxiety and alcohol ask for main symptoms and their frequency and consist of 40 items. The questionnaire has a diagnostic validity as good agreements between PHQ diagnoses and those of independent mental health professionals exist (inter-rater reliability: $\kappa = 0.65$; overall accuracy: 85%; sensitivity: 75% and specificity: 90%) (Gräfe et al., 2004; Spitzer, Kroenke, Williams, & the Patient Health Questionnaire Primary Care Study Group, 1999). The scoring system of the mood module allows to calculate internal consistency, which has shown to be good with Cronbach's α=.88 (Gräfe et al., 2004).

Eating Disorder Examination Questionnaire (EDE-Q; Hilbert, Tuschen-Caffier, Karwautz, Niederhofer, & Munsch, 2007)

The EDE-Q assesses the frequency of eating disorder attitudes, feelings and behaviour from the preceding 28 days. Four subscales (Restraint, Eating Concern, Weight Concern, Shape Concern) capture the attitudinal features while six single items refer to behavioural aspect of ED. The 22 items of the subscales are answered on a seven-point rating scale and form the EDE-Q global score. The latter is reported in this study, as it reflects the severity of ED psychopathology. Higher scores indicate greater psychopathology. The global score of the EDE-Q has shown excellent internal consistency with Cronbach's α=.95 (Hilbert et al., 2007).

Eating Disorder Inventory 2 (EDI-2; Paul & Thiel, 2005)

From the EDI-2, the scales *Drive for Thinness* and *Body Dissatisfaction* were used. The *Drive for Thinness* scale has six items and assesses the desire to lose weight, fear of weight gain and restricting tendencies. The subscale *Body Dissatisfaction* has nine items and assesses

displeasure about body shape by judging different body sites. All items are answered on a six-point rating scale. Higher scores indicate greater psychopathology. Both scales have shown good internal consistency in varied samples with Cronbach's α>.80 (Paul & Thiel, 2005).

Sociocultural Attitudes Towards Appearance Scale (SATAQ-3; Thompson, van den Berg, Roehrig, Guarda, & Heinberg, 2004)

From the SATAQ-3, the scales *Pressures* and *Internalization* were used in the German version of Legenbauer (in preparation). The *Pressures* scale assesses with seven items societal pressure from the media to be thin. The subscale *Internalization* assesses with nine items the extent to which someone internalises the social standards of thinness and attractiveness portrayed by the media. All items are answered on a five-point rating scale. Higher scores indicate greater psychopathology. Both scales have shown excellent internal consistency with Cronbach's α=.90 (Thompson et al., 2004).

German ATHLETE (Thiemann, Legenbauer, Vocks, Platen, & Herpertz, 2014)

Form the ATHLETE the scale *Sport and Body* was used. It assesses sports pressure to be thin. Pressure from the sports environment and pressure generated by an athlete's own beliefs that weight reduction increases performance are considered. Seven items are rated on a five-point rating scale. Higher values indicate higher pressure. This scale was identified when the factor structure of a German version of the ATHLETE (Hinton & Kubas, 2005) was examined for professional athletes. The scale has shown good internal consistency with Cronbach's α=.89 (Thiemann et al., 2014).

Procedure

Athletes were surveyed on average four months prior to an important contest (the Olympics, or European, National, Regional-Championships at junior or senior level). They were measured and weighed in private (in light sports clothing), and were asked to complete the questionnaires. A SCID-I interview (Wittchen et al., 1997) was conducted by a clinical psychologist (first author) to detect ED and other mental illnesses. The most common mental disorders in competitive sport populations were considered including anxiety and mood disorders (Hoyer & Kleinert, 2010; Schaal et al., 2011). Furthermore psychotic symptoms and substance abuse/addiction were taken into account (for a detailed list see legend Figure 2B). For non-athletes, height and weight were measured with 1kg adjustment for remaining clothes. Non-athletes completed an adapted set of questionnaires without sport measurements but additional screening instruments for mental health (PHQ (Gräfe et al., 2004), SCID-I screening questions (Wittchen et al., 1997)). Thirty-three (31%) non-athletes, who scored above the thresholds regarding mental health, eating behaviour, weight or menstrual cycles (see supplementary information 1) were interviewed via phone.

Eating disorder cases were discussed with a secondary ED expert (second author) and validated by a third blinded independent clinician. In addition, an overall diagnostic inter-rater reliability was calculated based on a sample of 30 randomly selected interview audio recordings and a blind assessment of the third expert. A Cohen's kappa coefficient of $\kappa = 0.914$ ($p < .001$) indicated good inter-rater reliability.

Data analysis

The statistical analysis was conducted with SPSS 20®. To test categorical data across groups, Chi-square or Fisher's exact test were used. Continuous data were analysed using one-factorial Analysis of covariance. In all tests, group membership was the independent variable and comparisons were performed between 1) aesthetic sports vs. ball game sports athletes, 2)

aesthetic sports athletes vs. non-athlete controls ($controls_{AS)}$ and 3) ball game sports athletes vs. non-athlete controls ($controls_{BS)}$. Because of their impact on eating-related variables, BMI (de Bruin et al., 2007; Stice, 2002) and age (Byrne & McLean, 2001; Jacobi et al., 2004; Torstveit et al., 2008) were included as covariates except when age was controlled by the age-matching procedure. Tests which target ED, disordered eating or sport-specific variables in connection with aesthetic sports athletes or body dissatisfaction in connection with non-athletes were carried out as one-tailed hypotheses due to the empirical results presented in the introduction. A hierarchical multiple regression analysis was conducted to test the predictive power of putative sports-specific and non-sports-specific risk factors for disordered eating among athletes. An alpha level of $p < .05$ was used. Bonferroni adjustments were applied for group comparisons (adjusted p-values $p = .0167$). Cramér's φ, Cohen's d and Partial η^2 as effect size are reported.

Results

Comparisons of group characteristics and mental health status

First, we compared both athlete groups and second, we contrasted athletes to their respective control group regarding the baseline characteristics. As expected ball game sports athletes were older and heavier than aesthetic sports athletes. Additionally, the latter also trained significantly more hours per week. Group details are displayed in Table 1.

Analysis regarding research question 1 revealed that eight aesthetic sports athletes, two ball game sports athletes and one in each of the non-athlete groups suffered from an ED (Fig. 2A). One aesthetic sports athlete was diagnosed with Bulimia nervosa, the remaining eleven individuals were diagnosed with Eating Disorder Not Otherwise Specified (EDNOS). The point prevalence of ED among aesthetic sports athletes was significantly higher compared to $controls_{AS}$ and ball game sports athletes. No significant differences were found between ball game sports athletes and their $controls_{BS}$. Regarding the frequency of other mental disorders, no significant differences were found between groups (Fig. 2B).

Insert Table 1 here

Insert Figure 2 here

Group comparisons of eating pathology and putative risk factor variables

Results regarding research question 2 and the presence of disordered eating in each group are presented below. For further details regarding means and standard deviations see Table 2.

Aesthetic sports vs. ball game sports athletes

Aesthetic sports athletes obtained significantly higher scores on the EDE-Q global score [F1,99 = 10.239, p = .001, ηpartial^2 = .094] and the EDI-2 Drive for Thinness scale [F1,99 = 13.880, p < .001, ηpartial^2 = .123]. They showed higher levels on the sport-specific factors including the ATHLETE Sport and Body scale [F1,99 = 21.246, p < .001, ηpartial^2 = .177] and significantly more aesthetic sports athletes 85% specialised before onset of puberty than ball game athletes 53% did [χ^2(2, N = 106) = 11.64, p < .01, φ = .33]. Aesthetic sports athletes also scored significantly higher on the non-sport-specific factors SATAQ-3 Pressures [F1,99 = 9.418, p = .003, ηpartial^2 = .087] and SATAQ-3 Internalisation [F1,99= 9.241, p = .003, ηpartial^2 = .085]. The two groups did not differ on the EDI-2 Body Dissatisfaction scale [F1,99 = 1.189, p = .278, ηpartial^2 = .012].

Aesthetic sports athletes vs. non-athlete controls$_{AS}$

Aesthetic sports athletes obtained significantly higher score on the EDI-2 Drive for Thinness scale [F1,89 = 11.334, p < .001, ηpartial^2 =.113]. Taking the adjusted p-value into account (p = .0167) a similar trend was shown for the EDE-Q global score [F1,89 = 4.449,p = .019, ηpartial^2 = .048]. Athletes did not differ from their controls$_{AS}$ in terms of non-sport-specific factors. Groups did not differ on the SATAQ-3 Pressures scale [F1,89 = .984, p = .324, ηpartial^2 = .011], the SATAQ-3 Internalisation scale [F1,89 =.295,p = .589, ηpartial^2 = .003] and the EDI-2 Body Dissatisfaction scale [F1,89 = .019, p = .446, ηpartial^2 < .001].

Ball game sports athletes vs. non-athlete controls$_{BS}$

Ball game sports athletes obtained significantly lower scores on the EDE-Q global score [$F_{1,111}$ = 7.287, p = .006, ηpartial^2 = .065], but not on EDI-2 Drive for Thinness scale, when applying the adjusted p-value of p=.0167 [$F_{1,111}$ = 4.404, p = .038, ηpartial^2 = .038]. Athletes showed lower levels than their controls$_{BS}$ on non-sport-specific factors including the

SATAQ-3 Pressures scale [$F_{1,111} = 22.166, p < .001, \eta partial^2 = .166$], the SATAQ-3 Internalisation scale [$F_{1,111} = 25.160, p < .001, \eta partial^2 = .185$] and the EDI-2 Body Dissatisfaction scale [$F_{1,111} = 5.225, p = .012, \eta partial^2 = .045$].

Insert Table 2 here

Prediction of athletes' eating pathology

To answer research question 3 a hierarchical regression was conducted. At step one, BMI and age contributed significantly to the regression model [$F(2,100) = 10.79, p < .001$] and accounted for 17.7% of the variation of the EDE-Q global score among athletes. Inclusion of all putative risk factors in step two explained an additional 57.3% of variation. The change in R^2 was significant [$F(7,95) = 40.65, p < .001$]. When all seven independent variables were included in step two, only body dissatisfaction and sports pressure were significant predictors (Table 3). Increase in these variables predicted higher pathology. SATAQ-3 predictors missed the significance level with $p = .079$ and $p = .074$.

Insert Table 3 here

Discussion

An increased risk for ED in several professional sports is widely recognised (Byrne & McLean, 2002; Sundgot-Borgen & Torstveit, 2004), though less certain is which factors contribute to the enhanced risk. This study examined the ED prevalence rates of German female professional athletes and non-athletes, as well as putative sport-specific and non-sport-specific risk factors for ED.

Prevalence

While the present study found no group differences in other mental disorders, groups differed significantly in prevalence of ED. Aesthetic sports athletes showed the highest rate of ED (17%), followed by ball game sports (3%) and non-athletes (2%). Similarly to other sport studies the most frequent ED diagnosis was EDNOS (Byrne & McLean, 2002; Ringham et al., 2006). Results from the EDE-Q and the EDI Drive for Thinness scale confirmed the aesthetic sports athletes' increased risk. Their high-risk status was in line with results of large-scale studies (Byrne & McLean, 2002; Sundgot-Borgen, 1993; Sundgot-Borgen & Torstveit, 2004). Compared with those studies, however, the prevalence in aesthetic sports athletes was less than half as high. This might be explained by different group composition, as the large-scale studies included the high risk group of dancers (Arcelus, Witcomb, & Mitchell, 2014), but did not consider team vaulters. Team vaulters may be exposed to less sports pressure, because their body requirements differ depending on their team position. With increasing age, body height and weight, vaulters often change their position within the team. In line with this interpretation Schneider et al. (2009) suggested that not all aesthetic sports have the same ED risk.

In contrast to the large-scale studies (Byrne & McLean, 2002; Sundgot-Borgen, 1993; Sundgot-Borgen & Torstveit, 2004), ball game sports athletes in this study had no enhanced

level of ED. Additionally, almost all self-report measures suggested that those athletes were healthier in terms of eating problems than non-athletes. Our ball game sample consisted of field hockey players only. Marshall and Harber (1996) exclusively investigated this group and also found no particular ED risk. It is possible that there may be factors specific to this group that influence eating and weight. Taking the risk factor results into account (see below), it might be possible that field hockey players benefit from a positive athletic participation effect, e.g. acting on self-esteem or body image (Schneider et al., 2009; Smolak et al., 2000; Zucker, Womble, Wlliamson, & Perrin, 1999), without paying the price of intense sports pressure.

Together with the reflections on team vaulters, this implies that it is worth judging sports individually for an exact ED risk assessment. The differences found in prevalence rates enabled us to perform the intended putative risk factor examination.

Putative Risk factors

In line with the assumption that putative risk factors are more prominent in groups with high disordered eating than in those with low (Kraemer et al., 1997), in this study putative risk factors were more prevalent in aesthetic than in ball game sports athletes.

Aesthetic sports athletes were more likely to have started sport-specific training before the onset of puberty than were ball game sports athletes. Since the discrepancy between the adult body and the ideal sports body is anyhow greater in aesthetic than in ball game sports (Thompson & Sherman, 2010), aesthetic sports athletes are at greater risk of developing a mismatch between the two body types (Sundgot-Borgen, 1994).

In support of the model of Petrie and Greenleaf (2007), aesthetic sports athletes also displayed the highest degree of sports pressure and differed from ball game sports athletes regarding two of the three investigated non-sport-specific factors. They reported more

societal pressure and a greater degree of its internalisation. Aesthetic sports athletes did not differ from non-athletes, however, in those non-sport-specific factors that might indicate the relevance of sports pressure, as suggested in other cross-sectional studies (Byrne & McLean, 2002; Gomes, Martins, & Silva, 2011; Krentz & Warschburger, 2011a) and by the result of the regression analysis.

Body dissatisfaction, the third assessed non-sport-specific factor, is not particular high among aesthetic sports athletes. Even though in line with previous findings (Hausenblas & Downs, 2001; Smolak et al., 2000), this is counter-intuitive as their ED prevalence is elevated, and body dissatisfaction is a major risk factor for ED (Stice, 2002). Furthermore, in the regression analysis body dissatisfaction turns out to be a significant predictor for disordered eating. A similar pattern emerged in work by Krentz and Warschburger (2011b): body dissatisfaction predicts disordered eating, but does not differ among high- and low-risk groups. The absence of group differences may (mis)lead to the assumption that body dissatisfaction plays a minor role in ED among athletes (Smolak et al., 2000). An explanation, which could be tested by comparing athletes with and without ED, could be as follows: Athletes with ED pathology are dissatisfied with their bodies, but their high body dissatisfaction scores are averaged out by the majority of athletes, who are satisfied with their bodies. In this case no group difference appears but body dissatisfaction could still be a relevant ED predictor for athletes like in this study.

The regression analysis revealed that the putative risk factors together are able to explain almost 60% of the variation in disordered eating and it underlines the need to consider both sport-specific and non-sport-specific factors. The same conclusion could be drawn from the Gomes et al. (2011), which assessed a broader variety of sport-specific factors, e.g. sports performance anxiety.

Strengths, Limitations and Perspective

The strengths of this study are the joint consideration of sport-specific and non-sport specific factors, the use of clinical interviews to detect ED, an inter-rater reliability of $\kappa = 0.914$ and avoidance of age-cohort effects; these features enhance the external validity. Nevertheless, when interpreting the data, the following limitations should be considered. The accuracy of prevalence rates in non-athletes might be affected by a possible selection effect and by the screening procedure, while the rates of aesthetic sports athletes might be underestimated by two coaches refusing their support and the heterogeneity of the group. It must be noted that, in general, cross-sectional findings are only the first step in terms of risk factor research and need to be followed by longitudinal studies. The interpretation is limited, furthermore, to the type of sports investigated and not all putative risk factors were considered e.g. those outlined in the new contextual approach to body dissatisfaction (de Bruin, Oudejans, Bakker, & Woertman, 2011). The sample size led to adequate power at moderate to large effect size levels, but to less than adequate statistical power at a small effect size level. In addition, due to the small number of ED cases, no logistic regression analysis to assess the predictive power of putative risk factors for ED could be performed (for details see(Peduzzi, Concato, Kemper, Holford, & Feinstein, 1996). To overcome the limitations, one might need longitudinal risk factor studies and large-scale prevalence studies with single-sport groups, where athletes are approached directly and more putative risk factors are assessed.

Conclusion

Based on clinical interviews, this study confirms elevated prevalence of ED among female German aesthetic sports athletes and shows that risk assessment should be carried out individually for different sports. All investigated putative risk factors qualify to be further tested in a longitudinal design. In future research special attention should be focused on

383 sports pressure and body dissatisfaction. There are strong indications that both sport-specific
384 and non-sport-specific factors need to be taken into account for prevention and treatment of
385 ED in athletes.

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544 **Table 1** Sample characteristics expressed as mean (standard deviation) or percentage
545 (number)

	Athletes		**Non-athletes**	
	Ballgame sports n=62	Aesthetic sports n=46	$Controls_{AS}$ n=46	$Controls_{BS}$ n=62
Age (years)	22.6 (3.6)[1]	16.6 (2.7)[1]	16.5 (2.6)	22.6 (3.6)
Body mass index (kg/m^2)	22.4 (2.0)[1,2]	20.0 (2.0)[1]	20.4 (2.4)	21.1 (1.9)[2]
Underweight[†]	1.6% (1)	4.3% (2)	0% (0)	4.8% (3)
Overweight[†]	11% (7)	0% (0)	2.2% (1)	3.2% (2)
Training volume (h/week)	13.9 (3.3)[1,2]	18.7 (8.9)[1,3]	3.1 (2.4)[3]	2.9 (2.1)[2]
National sports performance	13% (8)	13% (6)		
International sports performance	87% (54)	87% (40)		

546 BMI, Body Mass Index; $Controls_{AS}$, aesthetic sports controls; $Controls_{BS,}$ ball game sports
547 controls; h/week, hours per week.
548 [†]according to the WHO classification (World Health Organization, 1995) and standardized
549 percentile curves of BMI for German female adolescents (Kromeyer-Hauschild et al., 2001).
550 Means in the same row that share a superscript differ at $p<.001$.
551

552 **Table 2** Eating pathology and putative risk factors expressed as mean (standard deviation)

		Athletes		Non-athletes	
	α	Ball game sports n=57†	Aesthetic sports n=46	$Controls_{AS}$ n=46	$Controls_{BS}$ n=57
Eating Pathology					
EDEQ Global score	.95	0.7 (0.8)	1.1 (1.4)	0.7 (0.8)	0.9 (0.9)
EDI-2 Drive for Thinness	.90	13.4 (5.9)	17.4 (9.5)	12.8 (6.2)	14.4 (6.8)
Putative Risk Factors					
SATAQ-3 Pressures	.92	9.3 (4.0)	11.6 (5.8)	10.9 (5.6)	13.9 (6.5)
SATAQ-3 Internalization	.94	13.8 (7.0)	17.7 (8.6)	17.3 (8.1)	21.6 (8.9)
EDI-2 Body Dissatisfaction	.93	24.5 (9.4)	23.5 (11.2)	24.6 (9.3)	26.0 (10.7)
ATHLETE Sport & Body	.89	12.5 (5.9)	16.2 (8.3)		
Athletes specialised before puberty[1]		32 (53%)	39 (85%)		

553 BMI, Body Mass Index; $Controls_{AS,}$ aesthetic sports controls; $Controls_{BS,}$ ball game sports

554 controls; EDE-Q, Eating Disorder Examination Questionnaire; EDI-2, Eating Disorder

555 Inventory-2; SATAQ-3, Societal Attitudes Towards Appearance Scale-3.

556 † reduced sample sizes due to 5 missing questionnaires.

557 [1] Puberty onset for girls = ages 10 (Palo Alto Medical Foundation pamf.org)

Table 3 Summary of hierarchical regression analysis for variables predicting eating disordered pathology (EDE-Q global score) among athletes (n=103)

	B	SEB	β	95% CI
Step 1				
Constant	-1.802	0.93		(-3.639 to 0.036)
BMI	0.201	0.05	.43**	(0.109 to 0.292)
Age	-0.080	0.03	-.30*	(-0.13 to 0.030)
Step 2				
Constant	-0.925	0.586		(-2.089 to 0.238)
BMI	-0.043	0.034	-.091	(-0.109 to 0.024)
Age	0.011	0.016	.044	(-0.021 to 0.044)
SATAQ-3 Pressures	0.041	0.023	.185	(-0.022 to 0.088)
SATAQ-3 General Internalization	0.028	0.015	.197	(-0.003 to 0.058)
EDI-2 Body Dissatisfaction	0.040	0.009	.365**	(0.022 to 0.058)
ATHLETE Sport & Body	0.046	.013	.303**	(0.021 to 0.071)
Age at sport-specific training start	0.004	.022	.009	(-0.040 to 0.048)

BMI, Body Mass Index; EDE-Q, Eating Disorder Examination Questionnaire; EDI-2, Eating Disorder Inventory-2; SATAQ-3, Societal Attitudes Towards Appearance Scale-3.

R^2 = .18 for Step 1; Δ R^2 = .57 for Step 2, *p<.01, **p<.001.

563 **Supporting information 1** Interview criteria for non-athlete controls

Mental Health:

- Report of current or past mental disorders
- Report of in- or outpatient treatment for mental health reasons
- Positive results on PHQ Diagnostic or SCID-I Screening questions

Weight:

- Current or past underweight: BMI<18.5 kg/m^2 or a BMI<10th percentile for all younger than 18 years

Eating Behaviour:

- Self-reported eating disorders
- Report of pathogenic weight control methods
- Scores of EDI-2 subscales at or above the 95th percentile of healthy controls (EDI-2 DT>15; and EDI-2 BD>25)

Menstrual Cycle:

- Menstrual dysfunction defined as primary or secondary amenorrhoea

564 PHQ, Patient Health Questionnaire; SCID-I, Structured Clinical Interview for DSM-IV Axis

565 I Disorders; BMI, Body Mass Index; EDI-2, Eating Disorder Inventory 2.